DESIGN NOTES

Wide Input Range 1A LED Driver Powers High Brightness LEDs with Automotive and $12V_{AC}$ Supplies – Design Note 388

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Introduction

Today's ultrabright LEDs far exceed the performance of incandescent bulbs in both efficiency and lifetime. Taking full advantage of these features requires a correspondingly efficient and reliable LED driver, such as the LT®3474. The LT3474 is a step-down 1A LED driver that supports a variety of power sources, has a wide 4V to 36V input voltage range and is programmable to deliver LED current from 35mA to 1A at up to 88% efficiency. It requires minimal external circuitry and is available in a space saving 16-lead TSSOP package.

Automotive LED Driver

Figure 1 shows the configuration of the LT3474 operating from a 12V automotive battery input. As shown, the circuit can tolerate voltage swings from 4V to 36V, common in an automotive environment. With an integrated NPN switch, boost diode and sense resistor, the LT3474 cuts the external component count to a minimum. The high side sense allows a grounded cathode connection, easing wiring constraints. Both PWM and analog dimming are available with minor circuit modification; see the LT3474 data sheet for details.

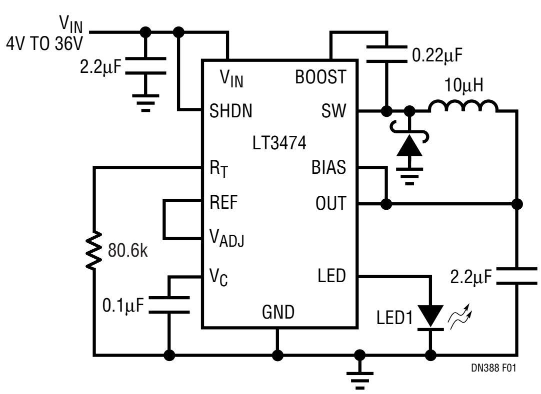


Figure 1. 4V-36V Input Voltage 1A LED Driver Requires Few Components

Driving LEDs from $12V_{AC}$ Input

The LT3474 directly regulates LED current, maintaining constant LED current over changing V_{IN}. The wide input range of the LT3474 allows direct connection to a rectified $12V_{AC}$ input. Using a small input capacitor, as shown in Figure 2, minimizes size. In this case, the LT3474 delivers nearly 1A of LED current as shown in Figure 3. Adding more capacitance to the input, as shown in Figure 4, holds the input voltage above the LED voltage. In this case, the LT3474 can deliver a constant LED current even with significant 120Hz ripple on the input as shown in Figure 5.

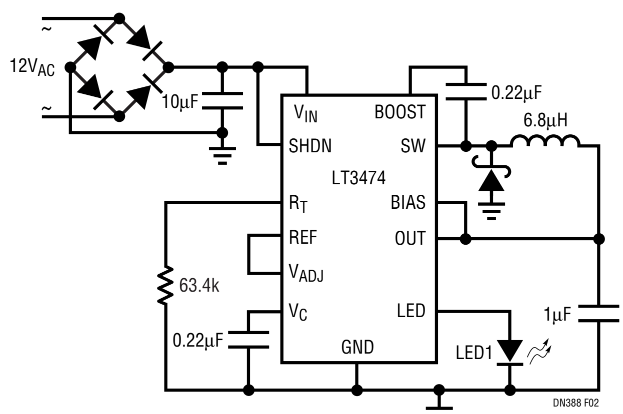


Figure 2. Using a Diode Bridge Allows the LT3474 to Drive an LED from a $12V_{AC}$ Input

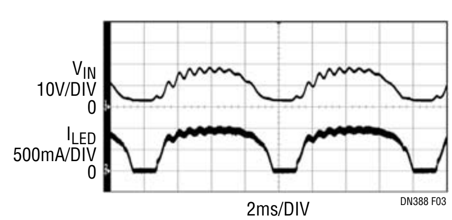


Figure 3. Using a 10µF Input Capacitance, the LT3474 Delivers Nearly 1A of LED Current with Smallest Board Size

Thermal regulation

The issue of heat management is at the core of many LED applications. A reliable solution maintains the longevity of the LED by keeping the LED junction temperature below the recommended limit. One answer to this problem is to mount massive heat sinks, wasting space and money. Figure 6 shows a better solution. The temperature of the LED is sensed by the thermistor mounted near the LED and is translated into a voltage signal to the V_{ADJ} pin. The V_{ADJ} pin reduces the current through the LED appropriately to meet the power derating specified by the Luxeon III Star manufacturer. Only slight modifications to the resistor values are required to adjust the circuit for use with other high brightness LEDs.

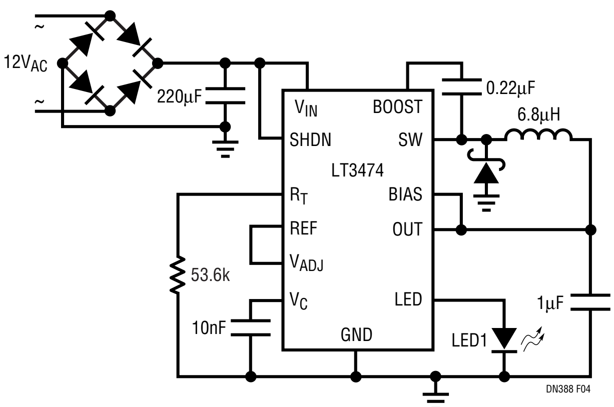


Figure 4. With a 220µF Input Capacitor, the LT3474 Supplies a Constant 1A Current to the LED

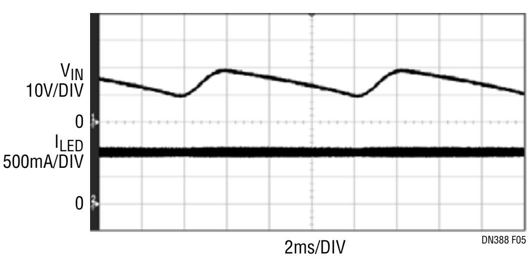


Figure 5. With a 220µF Input Capacitor, the LT3474 Delivers Constant 1A LED Current with Changing Input Voltage

Conclusion

High power white LEDs are fast becoming the lighting of choice in architectural, automotive, museum and avionic systems due to their efficiency, high quality light and long lifetimes. The LT3474 makes it easy to create compact, efficient, robust and versatile LED drivers from a variety of power supplies. Designers can now focus their time on creating imaginative new LED applications, instead of on LED drivers.

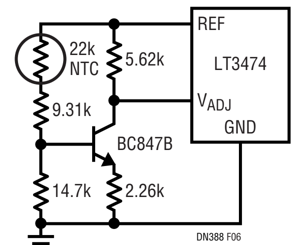


Figure 6. Compact, Economical Thermo-Regulating Circuit. The NTC and NPN, Mounted Close to the LED, Monitor the LED's Temperature

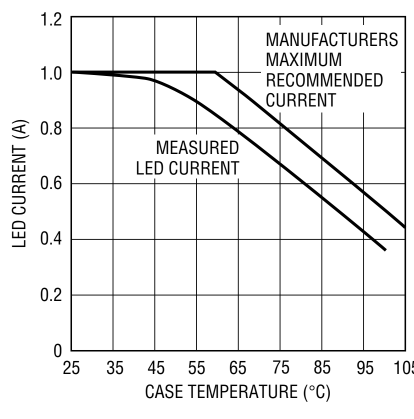


Figure 7. LED Current Safely Lies Within Specified Limits for the Luxeon III Star Power

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